

port 14 is easily accessible for connection or disconnection of an electronic module, as described below. In other embodiments, the sensor system 12 can be positioned differently. For example, in one embodiment, the port 14, the sensors 16, and/or the leads 18 can be positioned within the outsole 132, midsole 131, or foot contacting member 133. In one exemplary embodiment, the port 14, the sensors 16, and/or the leads 18 may be positioned within a foot contacting member 133 positioned above the foot contacting member 133, such as a sock, sockliner, interior footwear bootie, or other similar article. In a further embodiment, the port 14, the sensors 16, and/or the leads 18 can be formed into an insert or a liner, designed to be quickly and easily engaged with the sole structure 130, such as by inserting the insert between the foot contacting member 133 and the midsole 131, such as shown in FIGS. 4-5 and 7-10. Still other configurations are possible, and some examples of other configurations are described below. As discussed, it is understood that the sensor system 12 may be included in each shoe in a pair.

[0123] In one embodiment, as shown in FIGS. 7-9, the sensors 16 are force sensors for measuring stress, compression, or other force and/or energy exerted on or otherwise associated with the sole 130. For example, the sensors 16 may be or comprise force-sensitive resistor (FSR) sensors or other sensors utilizing a force-sensitive resistive material (such as a quantum tunneling composite, a custom conductive foam, or a force-transducing rubber, described in more detail below), magnetic resistance sensors, piezoelectric or piezoresistive sensors, strain gauges, spring based sensors, fiber optic based sensors, polarized light sensors, mechanical actuator based sensors, displacement based sensors, and/or any other types of known sensors or switches capable of measuring force and/or compression of the foot contacting member 133, midsole 131, outsole 132, etc. A sensor may be or comprise an analog device or other device that is capable of detecting or measuring force quantitatively, or it may simply be a binary-type ON/OFF switch (e.g., a silicone membrane type switch). It is understood that quantitative measurements of force by the sensors may include gathering and transmitting or otherwise making available data that can be converted into quantitative force measurements by an electronic device, such as the module 22 or the external device 110. Some sensors as described herein, such as piezo sensors, force-sensitive resistor sensors, quantum tunneling composite sensors, custom conductive foam sensors, etc., can detect or measure differences or changes in resistance, capacitance, or electric potential, such that the measured differential can be translated to a force component. A spring-based sensor, as mentioned above, can be configured to measure deformation or change of resistance caused by pressure and/or deformation. A fiber optic based sensor, as described above, contains compressible tubes with a light source and a light measurement device connected thereto. In such a sensor, when the tubes are compressed, the wavelength or other property of light within the tubes changes, and the measurement device can detect such changes and translate the changes into a force measurement. Nanocoatings could also be used, such as a midsole dipped into conductive material. Polarized light sensors could be used, wherein changes in light transmission properties are measured and correlated to the pressure or force exerted on the sole. One embodiment utilizes a multiple array (e.g. 100) of binary on/off sensors, and force components can be detected by “puddling” of sensor signals in specific areas. Still other types of sensors not mentioned herein may be used.

It is understood that the sensors can be relatively inexpensive and capable of being placed in shoes in a mass-production process. More complex sensor systems that may be more expensive could be incorporated in a training type shoe. It is understood that a combination of different types of sensors may be used in one embodiment.

[0124] Additionally, the sensors 16 may be placed or positioned in engagement with the shoe structure in many different manners. In one example, the sensors 16 may be printed conductive ink sensors, electrodes, and/or leads deposited on a sole member, such as an airbag or other fluid-filled chamber, a foam material, or another material for use in the shoe 100, or a sock, bootie, insert, liner, insole, midsole, etc. The sensors 16 and/or leads 18 may be woven into garment or fabric structures (such as sockliners, booties, uppers, inserts, etc.), e.g., using conductive fabric or yarns when weaving or knitting the garment or fabric structures. Many embodiments of the sensor system 12 can be made inexpensively, for example, by using a force-sensitive resistor sensor or a force-sensitive resistive material, as described below and shown in FIG. 9. It is understood that the sensors 16 and/or leads 18 also may be deposited on or engaged with a portion of the shoe structure in any desired manner, such as by conventional deposition techniques, by conductive nano-coating, by conventional mechanical connectors, and any other applicable known method. The sensor system can also be configured to provide mechanical feedback to the wearer. Additionally, the sensor system 12 may include a separate power lead to supply power or act as a ground to the sensors 16. In the embodiments described below and shown in FIGS. 7-9, the sensor system 12 includes a separate power lead 18A that is used to connect the sensors 16, to the port 14A-E to supply power from the module 22 to the sensors 16. As a further example, the sensor system 12 can be made by incorporating printed conductive ink sensors 16 or electrodes and conductive fabric or yarn leads 18, or forming such sensors on the foam or airbag of a shoe. Sensors 16 could be incorporated onto or into an airbag in a variety of manners. In one embodiment, the sensors 16 could be made by printing a conductive, force-sensitive material on the airbag on one or more surfaces of the airbag to achieve a strain gauge-like effect. When the bag surfaces expand and/or contract during activity, the sensors can detect such changes through changes in resistance of the force-sensitive material to detect the forces on the airbag. In a bag having internal fabrics to maintain a consistent shape, conductive materials can be located on the top and bottom of the airbag, and changes in the capacitance between the conductive materials as the bag expands and compresses can be used to determine force. Further, devices that can convert changes in air pressure into an electrical signal can be used to determine force as the airbag is compressed.

[0125] The port 14 is configured for communication of data collected by the sensors 16 to an outside source, in one or more known manners. In one embodiment, the port 14 is a universal communication port, configured for communication of data in a universally readable format. In the embodiments shown in FIGS. 3-5, the port 14 includes an interface 20 for connection to an electronic module 22, shown in connection with the port 14 in FIG. 3. In the embodiment shown in FIGS. 3-5, the interface 20 includes a plurality of electrical contacts, similarly to the interfaces 320, et seq. described below. Additionally, in this embodiment, the port 14 is associated with a housing 24 for insertion of the electronic module 22, located in the well 135 in the middle arch or midfoot